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WASHINGTON, D. C. 20036

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March 22, 1994

VIA HAND DELIVERY

William F. Caton
Federal Communications Commission
1919 M Street, N.W.
Washington, DC 20554

Re: Gen. Docket No. 90-314
Ex Parte Filing

Dear Mr. Caton:

Transmitted herewith, on behalf of Time Warner Telecommunications, is an original and two copies of a letter to Chairman Hundt and an accompanying paper prepared by David Lax, James Sebenius and Howard Raiffa entitled "Comparing Auctions of 20 MHz and 40 MHz PCS Assignments." This material is being submitted to Chairman Hundt today. Please include this material in the above-referenced docket.

Should there be any questions regarding this matter, please communicate directly with the undersigned.

Sincerely,

Richard Rubin

Richard Rubin
Counsel for Time Warner
Telecommunications

Enclosures

cc: See attached list
9919

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HARVARD UNIVERSITY

GRADUATE SCHOOL OF BUSINESS ADMINISTRATION

GEORGE F. BAKER FOUNDATION

JAMES K. SEBENIUS
Professor
Director, Negotiation Roundtable

SOLDIERS FIELD
BOSTON, MASSACHUSETTS 02163
Phone: 617-495-9334
Fax: 617-495-0708

March 18, 1994

The Honorable Reed E. Hundt
Chairman
Federal Communications Commission
1919 M Street, NW Room 814
Washington, DC 20554

Dear Chairman Hundt:

We have been asked by Time Warner Telecommunications to provide comment in General Docket 90-314 (RM-7140, RM-7175, RM-7618), Amendment of the Commission Rules to Establish New Personal Communications Services, on the following issue:

> Are the FCC goals in the PCS auctions better served by (1) auctioning smaller licenses (e.g., 20 MHz assignments) and allowing aggregation or (2) auctioning larger licenses (e.g., 40 MHz assignments), given that the fundamental limitations of 20 MHz license assignments and the fundamentally superior economics of larger assignments will drive potential PCS providers to base their plans on assignments that have greater bandwidth than 20 MHz?

We conclude that FCC goals are better served by auctioning larger license assignments because:

- Auctioning 20 MHz assignments and allowing for aggregation can lead to economically inefficient and otherwise undesirable outcomes including those in which:
  - Assignments do not go to those who value them most highly (in other words, the allocation is not economically efficient);
  - Rivals use the auction to prevent their competitors from achieving the economically efficient aggregation or raise the cost of capturing the value of aggregation, which has negative implications for rapid provision of affordable PCS service;
  - Firms bid more for assignments than their valuation of the assignments, which either leads to significant rates of default at the auction or would adversely impact the goal of rapid deployment of affordable service;
  - Opportunists obtain unjust enrichment because risk-averse bidders are afraid of paying more for an assignment than their valuations for it.
- One cannot rely on negotiations in the secondary market to correct these inefficiencies because these negotiations will be among a small number of relatively differentiated firms and/or consortia that compete and cooperate and will expect to compete and cooperate with each other in a variety of converging industries. While there is no model for general small

numbers bargaining problems that has predictive accuracy, experimental evidence and substantial practical experience suggest that some of these secondary market negotiations are likely to be time-consuming and costly and that some of the negotiations are likely to result in inefficient outcomes. In addition, the complexity of coalitional dynamics, the complexity of the various firms' interests across this industry and others, and the strategic importance of participation in the PCS industry leaves us unable to predict that the secondary market will correct these inefficiencies quickly, inexpensively or with certainty.

- These problems would be avoided or mitigated by auctioning larger assignments.

We base these conclusions on over 65 years devoted variously as academics with expertise in the areas of decision-making, negotiation, competitive bidding, negotiation and other strategic interaction and as businessmen with experience negotiating transactions and structuring and participating in competitive bidding. We are variously authors of well-known books on these subjects and have participated as advisors, investment bankers, merchant bankers and principals in a variety of significant transactions.

Sincerely,

Howard Raiffa
Professor

James K. Sebenius
Professor

David Lax
Principal,
The Conifer Group L.P.

Comparing Auctions of 20 MHz and 40 MHz PCS Assignments

by

Howard Raiffa
Professor
Harvard Business School

James Sebenius
Professor
Harvard Business School

David Lax
Principal
The Conifer Group L.P.

Comparing Auctions of 20 MHz and 40 MHz PCS Assignments

by Howard Raiffa, James Sebenius, and David Lax

1. **Purpose.** Time Warner Telecommunications has informed us that, given the fundamental limitations of 20 MHz license assignments and the fundamentally superior economics of larger assignments, potential PCS providers will be driven to base their plans on assignments with bandwidth greater than 20 MHz in order to provide timely, cost-effective PCS service. This need for a greater bandwidth is due to the following reasons, among others:[1]

   - Larger bandwidth assignments are necessary to permit the launch of PCS without waiting to clear the assigned bandwidth of all microwave users;
   - Larger bandwidth assignments are required to increase trunking efficiency and decrease investment in frequency reuse, thereby lowering subscriber costs;
   - Larger bandwidth assignments are required to establish coverage and capacity parity between 2 GHz PCS and 800 MHz cellular;
   - Larger bandwidth assignments are needed to support a greater array of future communications services - particularly in light of the need to accommodate microwave incumbents;
   - Larger bandwidths will provide capital efficiencies because the capital requirements for larger bandwidths do not increase proportionally with bandwidth; and
   - Larger bandwidths will provide operating cost efficiencies because operating costs will not increase proportionally with bandwidth.

   Time Warner Telecommunications has asked us to compare the effects of directly auctioning larger assignments (e.g., 40 MHz) with auctioning separate 20 MHz assignments and allowing aggregation. Specifically, we will address which of the following approaches better serves the FCC policy goals:
   (1) auctioning smaller licenses assignments and allowing aggregation or
   (2) auctioning larger license assignments.

   We conclude that directly auctioning 40 MHz assignments is superior to auctioning 20 MHz assignments and allowing for aggregation, because auctioning 20 MHz assignments can lead to economically inefficient and otherwise undesirable outcomes including those in which:

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[1]See Appendix A, PCS Assignment Bandwidth and The Public Interest, submitted to the FCC, September 10, 1993, by Alex Felker of Time Warner Telecommunications, for a detailed exposition of these reasons and others.

- Assignments do not go to those who value them most highly (in other words, the allocation is not economically efficient);

- Rivals use the auction to prevent their competitors from achieving the economically efficient aggregation or raise the cost of capturing the value of aggregation, which has negative implications for rapid provision of affordable PCS service;

- Firms bid more for assignments than their valuation of the assignments, which either would lead to significant rates of default at the auction or would adversely impact the goal of rapid deployment of affordable service;

- Opportunists obtain unjust enrichment because risk-averse bidders are afraid of paying more for an assignment than their valuations for it.

Morevoer, we argue that one cannot predict that negotiations in the secondary market will correct these undesirable and inefficient outcomes quickly, inexpensively, or with certainty.

2. **Experience.** The authors, Howard Raiffa, James Sebenius and David Lax, variously combine academic careers focused on decision-making, strategic interaction and negotiation with experience as advisors, investment bankers, merchant bankers and principals negotiating transactions and structuring and participating in competitive bidding. The authors have collectively had over 65 years experience in these areas. More detailed biographical information is provided below.

3. Outline of the Argument

3.1. The FCC, as part of its responsibility for licensing a new generation of personal communications services, must consider license bandwidth. We will consider two approaches and evaluate them on their ability to satisfy FCC goals: (1) auctioning 40 MHz assignments; and (2) auction 20 MHz assignments and allowing aggregation to 40 MHz assignments.

3.2. We agree with Milgrom and Wilson who argue in their affidavit dated November 8, 1993 before the FCC that because the negotiations in the secondary market following the auction will not "correct every inadequacy of the auction," that it is important to get the allocations of assignments made by the auction "as nearly right as possible". In order to get efficient allocations, in addition to utilizing an auction procedure that enables bidders to incorporate substantial

information into their bids, it will also be important to auction licenses with the right set of characteristics.

3.3. In particular, we will use some simple examples to show that an auction for a 40 MHz assignment will generally be simple and economically efficient in the sense that the assignment will go to the bidder that values the 40 MHz assignment the most.

3.4. By contrast, the same examples show that auctioning two 20 MHz assignments instead can easily lead to inefficient or otherwise undesirable outcomes in which:

3.4.1. 20 MHz and 40 MHz assignments do not go to those who value them most highly;

3.4.2. Rivals use the auction to prevent their competitors from achieving the synergies available from 40 MHz assignment ownership or to raise the cost of capturing the synergy;

3.4.3. Bidders pay more than their valuation for properties, with corresponding negative implications for the rapid delivery of affordable PCS service; and

3.4.4. Opportunists obtain unjust enrichment.

3.5. We argue that the secondary market cannot be relied upon to correct these undesirable results.

3.6. If 20 MHz assignments are auctioned instead of 40 MHz assignments, we would predict some failures to aggregate to 40 MHz, some aggregation which is extremely costly and slow, and some initial aggregation. In contrast, auctions for 40 MHz assignments guarantee that efficient aggregation is achieved. Therefore, 40 MHz assignments should be auctioned.

4. We argue below that one cannot rely on a smoothly functioning, efficient secondary market that will correct allocation problems that arise at the auction. Therefore, the question is:

Does the auction procedure lead to equivalent allocations from a policy perspective whether one auctions 20 MHz assignments or 40 MHz assignments?

We use simple examples to show that the allocations from an auction of 40 MHz assignments would be efficient but that an auction of 20 MHz assignments could lead

to serious and sometimes uncorrectable inefficiencies and outcomes that could impede the rapid deployment of affordable PCS service.

4.1. We wish to discover if there would be any differences in outcomes between an auction for a 40 MHz assignment and a simultaneous multiple round auction for two 20 MHz assignments. It will be instructive to examine in some detail what could transpire in the bidding process. Our aim is to show some of the undesirable results that could arise from the auction when the biddable items are all fractured into small component parts.

4.2. Our methodology will be simple. We push the simplest case we can imagine that still can illustrate some of the complexities we wish to demonstrate. The behavior that we discuss in the examples is plausible and well within the range of behaviors we have observed in practice. Indeed, one of the tests for evaluating this behavior is whether it is plausible. Some aspects of this behavior might not fit within the tight strictures of mainstream game-theoretic models in which all participants possess common knowledge of the situation and strategic rationality. Apart from experience, there are strong theoretical and empirical reasons to examine a wider range of behaviors than the tight equilibrium analysis of standard game models might permit. See Appendix B for a more detailed discussion of these issues and the reasons we choose to be guided by but not limited by the full assumptions of game-theoretic rationality.[2] In trying to forecast actual bidding behavior and understand potential bidding behavior in the PCS auctions, we need to ask not only "Could players with common knowledge of the situation and strategic rationality bid as in the example?" but "Could self-interested, profit-seeking intelligent people display the behavior in the example?"

4.3. So, in this spirit, we posit an auction for just two biddable components, two 20 MHz assignments A and B, and compare what could happen if these are auctioned separately or combined into an auction for A and B together (one 40 MHz assignment). Most of our message can also be best illustrated if we consider just three bidders, unimaginatively labeled: BP1 (for big player number 1), BP2 (for big player 2), and SP (for a company that wanted to bid to prevent the BPs from achieving efficient aggregation -- a spoiler -- or alternatively, for a small or local player). The BP players gain synergies from getting both A and B; in economic terms, they are super-additive players in the sense that they value A and B together more than the sum of getting A alone and B alone. The SP player does not aspire to get A and B jointly; indeed the SP player is sub-additive in the sense that SP's evaluation for A and B jointly is less

[2]See Sebenius, J., Negotiation Analysis: A Characterization and Review, Management Science 18, 1, January 1992, pp. 18-38.

than the sum of getting A alone and B alone. This could happen, for example, if SP were a local player with communications-related assets in the region and who wanted to own some spectrum in his region but faced capital constraints that would make it more difficult for him to pay a high amount to purchase two assignments or if SP were a player with existing telecommunications assets who placed high value on obtaining one assignment to block the others from reaping the synergies of aggregation.

4.4. In some of these scenarios, we will imbue the bidders with certain personality traits in order to best illustrate what could happen -- and in our opinion probably will happen given the vast number of spectrum assignments to be auctioned. In some scenarios, one or two of the big players will be high flyers, willing to take a risk; in other cases, we shall assume that they are prudent, conservative risk avoiders; in still others the big players may be aggressively competitive. We shall choose personality types to highlight what could happen.

4.5. *Example 1: Defensive Escalation.* The players valuations of assignments A and B alone and combined are shown in Table 1. Note that different players may have different technological proclivities about working with one assignment or another and may also value them differently depending upon a variety of factors including: a) which incumbent users are on the assignment; and b) different beliefs about how difficult it will be to move these users. These evaluations are known privately and are not common knowledge.

TABLE 1:

VALUE OF SPECTRUM BLOCKS TO BIDDERS

(A and B are 20 MHz spectrum assignments; A & B combines the two into a 40 MHz assignment)

BIDDER	A	B	A & B
BP1	7	8	22
BP2	3	7	20
SP	13	11	14

The 40 MHz assignment auctioned. In an open ascending auction for A and B combined (the 40 MHz assignment), BP1 with a reservation value of 22 will get the prize with a bid just exceeding 20; let's call this 20+.

The Two 20 MHz assignments auctioned separately. It is important to know just how this auction is executed. We assume here that there will be no combinatorial bid in addition to the separate auction of A and B alone. We shall concentrate our remarks to the case where A and B are auctioned simultaneously in successive round bidding, the procedure advocated by Milgrom and Wilson.

Let's paint the personality types: BP1 is fiscally conservative, cautious, and a bit reluctant to get caught out on a limb. BP2 is the risk taker.

Table 2 exhibits how the simultaneous bidding might proceed. At round 3, let's imagine the bidding has developed such that BP1 is the high bidder for A at 7 and BP2 is the high bidder for B at 7. Note that conservative BP1 is still with his standalone limits, whereas BP2 has bid 6 on A, well above his standalone valuation of 3. Still, BP2's bids sum to much less than his joint value of 20.

TABLE 2

SIMULTANEOUS MULTIPLE ROUND BIDDING FOR TWO 20 MHZ BLOCKS

(Note: (x,y,z) represent the bids of BP1, BP2, and SP respectively, where * indicates that the marked bid is the highest bid for the spectrum assignment at the time)

ROUND	A ALONE	B ALONE
3	(7*,6,6)	(6,7*,5)
4	(7,9*,8)	(8*,7,8*)
5	(-,9,10*)	(8,9*,8.5)
6	(-,11*,10)	(-,9,10*)
7	(-,11,12*)	(-,12*,10)
8	(-,13*,12)	(-,12*,10)
9	(-,13*,-)	(-,12*,-)

The table shows the next round (the fourth) of bidding. BP2 is elated with being the winner-so-far for A at the end of the round, but now he must do something about B. At the end of the round, BP2 is still under his value for the combined spectrum of 20.

Round 5 finds BP2 winning B but not A.

Round 6 is disturbing for BP2. He's winning A but not B and is at his combined maximum of 20. But BP2 muses, "I can't stop here because I'll be stuck with A at 11 and I only value A at 3 -- a whopping loss of 8. I have to cut my losses

and go after B. As long as I can win A and B for a total cost less than 28, I will be better off than I will be by stopping here."

So you see what happens in rounds 7 and similarly in round 8. Finally BP2 is successful at round 8 but BP2 pays 12 + 13 or 25, over-extending himself beyond his value of 20 for A and B together. Furthermore, BP2 gets both assignments even though BP1 values both more highly! An inefficiency -- since the assignments are not in the hands of the party that values them most highly. Moreover, having bid 25 for assets worth 20 to him, BP2's ability to rapidly develop and provide PCS service will be limited. Thus major policy goals do not appear to be well-served by this outcome.

4.6. One might be tempted to argue at this point that such an outcome would not be rational, and therefore would not occur. But, having bid beyond his standalone value for A, it was rational for BP2 to bid in excess of his value for A and B in order to reduce his losses. One might be tempted to argue instead that BP2, knowing that he might be in a position to win one of the two assignments at an amount in excess of his standalone values and would feel compelled to bid on the other assignment even if he were in a net loss position, would not bid on either property beyond his standalone value. Yet, he would be unlikely to capitalize upon the synergy reflected in his valuation of A and B together. While a rather risk-averse player might forego any chance of capturing the synergy to avoid taking a loss, individuals who are risk-neutral, modestly risk-averse, or risk-prone would likely be advised to risk a modest loss on one assignment if they felt that the probability of winning both assignments and capturing significant synergy was reasonably high. Thus, both acts, risking a loss on one assignment in the expectation of also winning the second assignment and paying more for both assignments than one's standalone value to avoid a bigger loss on one object, can be rational.

It is probably worth mentioning here that bidders can and are likely to reach similar outcomes through less rational processes. The recent auction of Paramount went for roughly $2 billion more than analysts' valuation of the company. Analysts attributed the overbidding to a battle of ego (and perhaps a non-economic concern over justifying sunk costs) between Viacom's Sumner Redstone and QVC's Barry Diller. A similar phenomenon was at work when Robert Campeau outbid Macy's for Federated Department Stores. Such situations are well-captured by the both-pay ascending auction or escalation

game described by Raiffa[3] and originated by Shubik[4]. In this escalation game, experimental evidence shows that people following the specialized rules of this auction routinely pay more than $10 for a $10 bill. And, following the rules of the simultaneous, multiple round auction, bidders may well pay more for a set of assets than their valuation for the assets.

4.7. *Example 2: Offensive Escalation.* In this variation, let us suppose that the small player SP values A and B at really low values, but that the BP values are as in Table 1.

The 40 MHz Auction. Thus, the outcome of the 40 MHz auction is clear: BP1 buys A and B for 20+.

The 20 MHz Auction. If instead we auction A and B separately, in the early rounds, it becomes apparent that it is a contest between BP1 and BP2. But now let us assume that BP1 is also macho, gung-ho and both are fiercely competitive with each other. By round 5, say the bidding puts BP2 ahead for A and BP1 ahead for B. See Table 3. But now they take turns escalating their bids and going way above their original position. If at any step both quit, each has only one of the two coveted prizes and they have paid way over their standalone values. Much like Sumner Redstone and Barry Diller, their competitive attitudes may have led them to dramatically overpay for the assignments and they may be hard-pressed to rapidly develop attractive service at affordable prices.

TABLE 3

SIMULTANEOUS ROUND BIDDING FOR TWO 20 MHZ BLOCKS

(Note: (x,y,z) represent the bids of BP1, BP2, and SP respectively, where * indicates that the marked bid is the highest bid for the spectrum assignment at the time)

ROUND	A ALONE	B ALONE
...		
5	(8,9,-)	(10*,9,-)
6	(10*,9,-)	(10,11*,-)
7	(10,11*,-)	(12,11,-)

[3]Raiffa, H. The Art and Science of Negotiation, Harvard University Press: Belknap Press, Cambridge, MA, 1982, pp. 85-90.

[4]Shubik, M., The Dollar Bill Auction: A paradox in noncooperative behavior and escalation, Journal of Conflict Resolution 15, 1971, PP. 109-111.

...		

This dynamic can be controlled if the bidders are allowed to default on their bids so they are not stuck with having to pay an excessive amount for one standalone prize. But, then again if default is easy, there is little need for restraint on the bidders part not to enter the escalation game. Indeed, small penalties for default may encourage the bidding opportunists, as we see below.

4.8. *Example 3: Opportunism.* The players' valuations of the spectrum assignments are shown in Table 4. Assume both BP1 and BP2 are risk averse and are afraid to get into an escalatory entrapment. They cannot easily default without hurting their chances on other bids. SP on the other hand is not worried about other bids and thus his default penalty is not severe enough to deter the following risky behavior.

TABLE 4:

VALUE OF SPECTRUM BLOCKS TO BIDDERS

(A and B are 20 MHz spectrum assignments; A & B combines the two into a 40 MHz assignment)

BIDDER	A	B	A & B
BP1	3	5	16
BP2	5	6	18
SP	4	3	6

The 40 MHz Auction. If A and B were auctioned together, BP2 would win both at 16+.

The 20 MHz Auction. In this example, if all bids were non-strategic, BP2 would win A at 4+ and B at 5+. But, SP strategically bids 6 for A and BP2 is reluctant to go up. BP2 thinks he will try to obtain A from SP in the secondary market. BP2 should be willing to spend up to 12 for A in the secondary market. Suppose BP2 purchases A from SP for 11. Thus government has received 11+ (6 from SP for A and 5+ from BP2 for B). SP nets 5, more than 30% of the overall value of the auction.

To get 11, SP had to hold out until BP2 needed the property to construct the system. As part of the bargaining, both parties made investments as if they were going ahead without the transfer. Thus, the ability of BP2 to build the system was delayed and made more costly by the opportunistic behavior of SP.

Beyond noting that auctioning off 20 MHz assignments can lead to this sort of unjust enrichment described above, we suspect that the knowledge that smaller, relatively less expensive 20MHz assignments will be auctioned and that the big players will aggregate these smaller assignments may stimulate new entrants to the bidding pool who are primarily motivated by opportunism.

4.9. *Prudent Risk-Taking Leads to Overpaying for a 20 MHz assignment.* It is quite possible for a bidder to pay more for a 20 MHz assignment than the standalone value given to that assignment by any of the bidders because he anticipates winning the other assignment and reaping various synergies. If he does not win the other assignment because it is valued highly by another bidder, he will take a loss on the first assignment. While he will have an incentive, as in Example 1, to bid beyond his value for A and B together, he may not win the second assignment and the economically efficient aggregation would not occur. If the winning bidder pays more for the spectrum than his or any other bidder's value for it, the bidder may be unable to finance the development of it or may only be able to develop it slowly or without any capacity for technological innovation or advanced service. As such, this result could conflict with the policy goal of rapid provision of service.

4.10. *Rivalrous behavior may lead to inefficiencies.* The major players in this auction are limited number of large firms in the cable, telecommunications, telephone, cellular telephone, entertainment and other industries. These firms will be competing with and/or cooperating with each other in a variety of different business areas.

4.10.1. Some firms will expect to compete with others and will use the bidding and the secondary market to frustrate their competitors' interests, in part by bidding high for assets that they believe their competitors would want.

4.10.2. Because PCS is part of a broader competitive arena, some bidders with existing telecommunications infrastructure may see their primary interests as preventing the formation of formidable new competitors and thus would have an interest in assuring that otherwise economically efficient aggregation does not take place. In particular, cellular incumbents or other firms might overbid for and retain 20 MHz assignments in key BTAs both within and outside their service areas to block the development of competition.

4.10.3. In other cases, they may intend to enable their competitors to aggregate but may intend to use the secondary market to a) delay and frustrate their competitors attempts to establish a strong early position in the industry; and b) extract significant value for the license in order to reduce the competitor's ability to rapidly provide service and be a strong competitor on price and other features.

4.10.4. A firm may expect that its rivals will succeed in winning licenses that it considers strategically important. The firm may feel compelled to "take hostages" as a defensive measure so that it has something to trade in order to gain the licenses it values most highly. The swapping of these licenses is likely to occur, if at all, only with significant delay and transaction costs.

4.10.5. It is not unlikely that this behavior will generate antagonistic emotions in the rivals and will affect subsequent bidding and negotiations.

4.11. *Capital constraints may lead to inefficiencies.* Bidders are likely to have overall capital constraints, which may result in inefficient allocations. A bidder will be bidding simultaneously on a variety of properties. Given its impressions of its competitors' valuations and bidding strategies for various licenses, the bidder might conceivably forego bidding (or stop bidding part way) on one set of licenses to focus on another when it in fact placed higher value than competitors on the first set of licenses but not on the second set. Because of the unpredictability of the bargaining in the secondary market and other companies' quests for strategic advantage in the broader multimedia market, the highest valuer may never get the property or may do so in a way that makes speedy delivery of service difficult or impossible.

4.12. *Difficulty in drawing inferences about other bidders may lead to inefficiencies.* Uncertainty about bidder types and valuations might also cause the auction mechanism to yield inefficient allocations. During the bidding, the bidders will be trying to learn from the others' bids given whatever information they receive. Does another bidder have a high or low valuation for these licenses? Is the bidder aggressive or cautious given its valuation? It may be difficult to tell whether a bidder is cautious but places a high valuation on a set of licenses or is aggressive but places a low valuation on the licenses. If a bidder misjudges a competitor, it may bid aggressively when it does not need to or drop out of bidding even if its valuation of an asset was higher than that of the competitor.

4.13. Auctioning 20 MHz assignments even by thoughtful auction procedures can still lead to a variety of inefficient and undesirable outcomes. Disaggregating the 40 MHz assignments and requiring the aggregation to occur at the auction or in the

secondary market opens the door to opportunism, risk-taking behavior, rivalrous behavior, offensive and defensive escalation, confusion and many other behaviors and factors that lead to inefficiency, transactions costs, and delay in providing affordable service. All these problems can be mitigated by auctioning 40 MHz assignments instead.

5. **The secondary market negotiations are likely to be unpredictable, difficult and time-consuming.**

5.1. Most economic analysis of auctions assumes a smoothly functioning, frictionless secondary market. Thus, in choosing an auction mechanism, it may not be critical that allocations are efficient because corrections take place easily in the secondary market. Moreover, the implicit presumption is often that not much value is left to be captured in the secondary market because the difference between the winning bid for an object and the highest valuation of it is not that great. Such assumptions may be valid when there are a large number of relatively undifferentiated bidders.

5.2. In contrast, the secondary market from PCS auctions will involve bargaining among a relatively small number of relatively differentiated firms or consortia.

5.2.1. The major players in this auction will be consortia of a limited number of large firms in the cable, telecommunications, telephone, cellular telephone, entertainment and other industries. A substantial proportion of these firms will bring to the process rather different assets that will affect their valuation of various PCS assets. These include long distance carriers that could potentially use PCS to avoid local access charges to local exchange companies, cellular companies that may wish to block the formation of effective competitors in the region where they are cellular players, cable companies that intend to utilize their cable assets in combination with PCS licenses, and so forth. These consortia will be competing with and/or cooperating with each other in a variety of different but converging industries. As we discussed earlier, given their competition in other arenas, some will have an explicit agenda to frustrate the ambitions of their competitors to establish a viable presence in PCS and would view this as a powerful interest in secondary market negotiations.

5.2.2. There is no accepted general theory for bargaining among a small number of players that has predictive accuracy. As Appendix B discusses, even in relatively simple bargains with tightly constrained structure, the predictions of standard game-theoretic models are refuted by data from experiments that have been carefully designed to mirror the perhaps somewhat unrealistic

assumptions of the models and bargained outcomes in these experiments are often inefficient.[5]

5.2.3. A variety of factors will likely exacerbate the deviation between predictions and reality in the actual negotiations. First, one should keep in mind that there is significant uncertainty about the nature and size of the business opportunities that will be created by the installation of PCS. Some companies, such as Walt Disney, have publicly stated their belief that the opportunities are likely to be small. Others see much greater potential. In the actual negotiations, then, there will be confusion about what one's goals should be and about how the other firms evaluate the opportunity, non-economic motivations such as conflicts among CEO's egos, complex economic motives that follow from the interaction of these firms in various industries, and various attitudes toward risk ranging from highly risk-averse to risk-prone. All these factors make it difficult to predict that negotiated outcomes will be efficient.[6] Moreover, in the secondary market, firms will form coalitions to reallocate licenses. The lack of predictability of coalition formation, and the often twisting coalitional dynamics, make it even more difficult to predict that the ultimate negotiated outcomes will be efficient.

5.2.4. Several predictions are easier to make: Some of the secondary market negotiations will be expensive and time-consuming. As we discussed earlier, rivals will use the secondary market to inflate their competitors' costs of doing business. Transactions that may appear irrational or hard to explain will occur. Some transactions that economic efficiency would seem to dictate will not happen.

5.3. With a small number of relatively differentiated bidders who are rivalrous, uncertain about the size and nature of the business opportunities afforded by PCS, and will bring in CEOs' reputations and egos, the standard economic assumptions about a secondary market with large numbers of rational and

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[5]For a recent elaborated example and summary of many related studies, see Kahn, L. and Murnighan, K., A General Experiment on Bargaining in Demand Games with Outside Options, American Economic Review, vol 83, No. 5, December 1993, pp. 1260-1280.

[6]This complex reality makes it extremely dubious that the assumption that the features of the game are common knowledge would be met. Yet, as the pre-eminent game theorist Aumann unequivocally concluded, "The common knowledge assumption underlies all of game theory and much of economic theory. Whatever be the model under discussion, whether complete or incomplete information, consistent or inconsistent, repeated or one-shot, cooperative or non-cooperative, the model itself must be assumed common knowledge; otherwise the model is insufficiently specified, and the analysis incoherent." See Aumann, R. J. (1989:31). Game Theory. In J. Eatwell, M. Milgate, and P. Newman (Ed.), Game Theory (pp. 1-53). New York: Norton.

relatively undifferentiated players market seem inappropriate. A reliance on the secondary market to sort allocation problems that come from an auction will not necessarily lead to speedy provision of service or economically efficient allocations.

6. Summary

6.1. Section 4 provided a number of examples of inefficiencies and other undesirable outcomes that would arise if 20 MHz assignments were auctioned. In contrast, auctioning 40 MHz assignments did not lead to these problems.

6.2. Section 5, supported by Appendix B, argues that given the complexities of the situation, the strategic importance of PCS spectrum to potential bidders, the interrelationship between this industry and other related industries, and the inherent unpredictability and frequent inefficiency of bargaining with a small number of bargainers, the secondary market cannot be relied upon to correct inefficiencies and other problems generated by the auction.

6.3. We therefore conclude that larger assignments such as the 40 MHz assignment we used in our example should be auctioned in preference to 20 MHz assignments.

7. Background and Experience

7.1. Howard Raiffa, James Sebenius and David Lax combine academic careers variously focused on decision-making, strategic interaction and negotiation with business experience negotiating transactions and structuring and participating in competitive bidding.

7.2. *Howard Raiffa* is Frank Plumpton Ramsey Professor of Managerial Economics at Harvard Business School and has held joint appointments as a professor at the Kennedy School of Government, the Statistics Department and the Economics Department at Harvard University. On leave from Harvard, he helped to found the twelve nation International Institute for Applied Systems Analysis in Laxenburg, Austria and served as its first Director. Prior to that, he served as a professor of Mathematical Statistics at Columbia University.

7.3. His academic career has focused on game theory, decisions under uncertainty, negotiation and dispute resolution, and competitive bidding.

7.4. He received a B.S. in Actuarial Mathematics, and M.S. in Statistics, and a Ph.D. in Mathematics from the University of Michigan. He received an SSRC training fellowship in economics and psychology at the University of Michigan. He subsequently received fellowship grants from the Center for Advanced Study in the Behavioral Sciences, served as Director of the Ford Foundation Institute of Basic Mathematics for Application to Business, and served as Ford Visiting Research Professor at Stanford University.

7.5. His professional honors include being named a Fellow of the Institute of Mathematical Statistics, the American Statistical Association, the Econometric Society, the American Institute for Decision Analysis, the Association for Public Policy Analysis and Management, and a member of the American Academy of Arts and Science. He received a Special Citation from the Soviet Academy of Sciences, the Lanchester Prize for best publication in Operations Research in 1976 (for *Decisions with Multiple Objectives* written with Ralph Keeney) awarded by the Operations Research Society of America, the 1984 Distinguished Contribution Award from the Society of Risk Analysis, the Frank P. Ramsey Medal for Outstanding Contributions to Decision Analysis awarded by the Operations Research Society of America, and the Melamed Prize awarded by the University of Chicago Business School every two years for an outstanding work of scholarship (for *The Art and Science of Negotiation*). He has received honorary doctorates from Carnegie Mellon University and the University of Michigan.

7.6. His Ph.D. thesis dealt with solution concepts to a two-party bargains and developed one of the solution concepts that has remained prominent in game-theoretic analysis. *Games and Decisions* (written with Duncan Luce in 1957) remains a classic in game theory but also raises questions about the limits of the game-theoretic approach in analyzing actual interactive conflict situations. Before returning to negotiations and other competitive decisions, Raiffa wrote a number of books concerning individual decision-making. He then returned to apply the insights about individual decision-making under uncertainty to interactive situations such as negotiation and bidding but chose to apply less restrictive and more realistic assumptions about individual behavior than that used in standard game-theoretic models. In *Games and Decisions* and *The Art and Science of Negotiation* and elsewhere, he has written about various auction procedures. He is currently producing a multimedia course on competitive and interactive decisions which prominently includes analyses of auctions and bidding.

7.7. Professor Raiffa has served as a consultant to a variety of corporations regarding decisions, negotiations and competitive bidding. His experience with regulated industries includes his role as member of the Safety Advisory Board for GPU Nuclear (Three Mile Island).

7.8. *James Sebenius* is Professor of Business Administration at the Graduate School of Business at Harvard University and Director of the Harvard Business School-Kennedy School of Government Negotiation Roundtable. He previously served as Assistant and Associate Professor of Public Policy at the Kennedy School of Government at Harvard University. He serves on the three-person Executive Committee of the Inter-University Program on Negotiation at Harvard Law School.

7.9. Sebenius holds an undergraduate degree (*summa cum laude*) from Vanderbilt University in Mathematics and English, a masters degree in Engineering-Economic Systems from Stanford University's Engineering School, and a Ph.D. from Harvard in Business Economics. In 1989, Sebenius was selected by the Japanese Junior Chamber of Commerce as one of the Ten Outstanding Young Persons (under 40) from around the world, an honor that involved an extended visit to Japan, meetings with many corporate leaders, and an audience with the new Emperor and Empress.

7.10. Professor Sebenius has devoted his career to the study and practice of negotiation and other strategic interaction. His book with David Lax, *The Manager as Negotiator*, studies negotiation and other strategic interaction between and within firms. His book *Negotiating the Law of the Sea* applies

economic principles to the analysis of an extremely complex multiparty negotiation. He is the author of numerous scholarly articles.

7.11. On leave from Harvard from 1984 through 1988, he was first hired by investment banker Peter G. Peterson as a full-time negotiation advisor, and then helped to found as Vice President the Blackstone Group, a New York investment banking firm. In its first year, Blackstone announced transactions valued at over $11 billion and advised over a dozen major corporate clients (including Squibb, American Can Company, American International Group, Inc., Armco Inc., COMSAT, CSX Corp., Eaton Corp., Firestone Tire and Rubber, Saatchi and Saatchi Company PLC, and Sony Corporation) on a wide variety of financial and strategic negotiations including mergers and acquisitions, joint ventures, recapitalizations, and divestitures. This activity involved assisting in the organizing of or participating in auctions or competitive bidding for the sale of companies. Subsequently, Blackstone has raised over $800 million in equity for Blackstone Capital Partners and has acted as primary financial advisor on three of the four largest U.S.-Japanese deals to date. Since returning to Harvard, Sebenius has continued to work actively as Special Advisor to the firm.

7.12. Sebenius served from 1976 to 1977 as assistant to the Administrator of the National Oceanic and Atmospheric Administration in Washington, and from 1977 to 1980 with the State Department on the U.S. Delegation to the Law of the Sea Negotiations led by Ambassador-at-Large Elliot Richardson. In 1984, he was elected a term member of the Council on Foreign Relations in New York. From 1989-1992, he was advisor to the Advisor, Select Automotive Panel, a joint U.S.-Canadian body established following the U.S. Canadian Free Trade Agreement to deal with outstanding auto trade issues; the Panel consists of the heads of the three major auto companies, the heads of the United Auto Workers and the Canadian Auto Workers, as well as numerous auto industry representatives. He was also a member of the Auto Parts Advisory Committee, United States Department of Commerce (appointed by the Secretary of Commerce in 1990).

7.13. *David Lax* is a Principal in The Conifer Group L.P., which provides strategic and financial advisory services to firms and government agencies in the infrastructure, energy, environmental and other industries. Lax is also a co-founder and principal of The Negotiation Group, a firm that has provided seminars and advisory services in negotiation and bidding to corporate and government clients including S.G. Warburg Group Ltd., Minet plc, Lederle Labs, Sandoz Pharmaceutical Corporation, Glaxo, the Merieux Institute, Petroleos de Venezuela, the Foreign Ministry of Venezuela, Reuters, Hewlett-Packard, GE, the Blackstone Group, Charterhouse Group International, AIG, American Research and Development Corporation, North West Water plc, the

Veterans Administration, the Department of the Interior and the National Science Foundation.

7.14. Lax was previously employed by American Venture Investments Inc., a subsidiary of ICF Kaiser Engineers Inc., and served as Managing Director of Environmental Capital Management, an affiliate of ICF, managing investments in and providing financial and other advisory services to environmental firms. Prior to that, Lax was Vice President of First City Capital Corporation, a merchant bank where he supervised analysis of and negotiated private equity transactions in middle-market and venture firms and was responsible for the development of new business ventures. In addition to a series of direct investments and joint ventures in the environmental area, he was involved in negotiations to privatize the two largest companies in one emerging market country.

7.15. Lax served as an Assistant Professor of Business Administration at Harvard Business School. He co-founded The Negotiation Roundtable, an ongoing research forum with Howard Raiffa and James Sebenius, aimed at analyzing a wide number of actual negotiations to draw out their conceptual and theoretical implications, and served as its Director. He served on the Steering Committee of the Inter-University Program on Negotiation at Harvard Law School.

7.16 Lax received an A.B. (*magna cum laude*) in Statistics from Princeton University and M.A. and Ph.D. degrees in Statistics from Harvard University.

7.17. Lax is the co-author with James Sebenius of *The Manager as Negotiator*, which lays out prescriptive analysis for negotiations between and within organizations, and is the author of numerous scholarly articles.

7.18. Lax's experience with regulated industries includes investments in companies in the environmental industry, including a permitting project in the hazardous waste area, work with electric utilities, and work with pharmaceutical companies.

PCS ASSIGNMENT BANDWIDTH AND THE PUBLIC INTEREST

by

Alex D. Felker
Time Warner Telecommunications

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